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INTAKE OF PCB FROM FATTY FOODS

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Introduction

The Danish monitoring programme for contaminants in food includes investigations of persistent organochlorine contaminants such as PCB (polychlorinated biphenyls) and compounds that have earlier been widely used as pesticides (for example DDT)[1]. They are included due to their potential health hazardous effect. Because these substances are slowly degradable and tend to accumulate in fatty tissues they can enter the food chain and therefore be found especially in fatty food items e.g. fish, animal fat, eggs and milk. As a consequence of the intake of fatty food items these compounds can therefore be found in humans. Results from the chemical analyses are combined with data on the consumption of the concerned foods items in calculations of the intake of the substances by the adult Danish population. In this paper selected results from the Danish monitoring programme are presented in relation to intake estimates of organochlorine compounds illustrated using PCB results.

Methods and Materials

Samples: From 1998 to 2003 3552 samples of 36 different food categories including *e.g.* egg, milk, cheese, animal fat and fish were analysed in the Danish food-monitoring programme.

Compounds: All samples were analysed for their content of the following organochlorine pesticides: α-HCH (hexachlorocyclohexane), β-HCH, γ-HCH (lindane), HCB (hexachlorobenzene), heptachlorepoxid, aldrin, dieldrin, *p,p'*-DDD, *p,p'*-DDE and *p,p'*-DDT. Furthermore samples were analysed for the following PCB congeners: PCB28, PCB52, PCB101, PCB105, PCB118, PCB138, PCB153, PCB156, PCB170 and PCB180.

Sample clean-up: Fat was extracted from the samples and about 0.6 – 0.8 g of fat was added to a Florisil column deactivated by water and eluted with dichloromethane:pentane (1:4). The eluate was carefully evaporated and the sample dissolved in isooctane. The final sample was analysed by gas chromatography using two different columns and electron capture detectors.

GC-ECD parameters: Perkin Elmer autosystem gas chromatograph. Column: 50 m CP-Sil-5CB (Chrompack) and 60 m DB-17 (J&W), 0.25 mm i.d., 0.25µm film thickness. Carrier gas: Helium, 15 psi (CP-Sil-5CB) or 37 psi (DB-17). 2 µl injected splitless, splitless time 2.5 min. Injector held at 220°C. Temperature programme: 90°C for 1 min., 30°C/min. to 180°C in 10 min., 2°C/min. to 240°C, 10°C/min. to 280°C in 20 min. (CP-Sil-5CB) or 30 min. (DB-17). Detector temperature 320°C. PCB congeners and organochlorine pesticides were quantified by comparing responses with those of standard mixtures. Limits of detection for organochlorine pesticides and PCB congeners were 0.5 to 4 µg/kg.

Results and discussion

Intake estimates are based on the dietary intake data collected in the Danish nationwide food consumption survey 2000-2002[2]. The food consumption data were sampled throughout the 3 years in order to take into account any possible seasonal variation in dietary habits. The representative sample of Danes included a total of 4120 respondents (2167 female and 1953 male) aged 4-75 yr. The Danish nationwide food consumption

survey used a seven-day prospective food record with a pre-coded (semi-closed) questionnaire that included answering categories for the most commonly eaten foods and dishes in the Danish diet. The food amounts eaten were given in household measures, e.g. pieces, glasses, cups, spoons and by use of photos. These portion sizes were used in the conversion of the reported amounts to weight (grams). Composite foods (e.g. dishes) were split up into ingredients by means of standard recipes. Due to the simplified design of the questionnaire, the total diet could be represented by the intake of 333 food items. The final result of these conversions was then recalculated and expressed as the daily mean intake for the seven-day food register of each participant in the survey.

Based upon the individual's data, it was possible to describe the intake distribution of both foods and chemical contaminations for the population divided into children (4-14 years of age) and adults (15-75 years of age). For calculations of the intake of contaminants in this paper, the individual-level consumption of each of the food items was multiplied by a qualified estimate of the contaminant content in that particular food item. The result of this is a distribution of the contaminant intake among adults. The intake distribution within the population has been described using an average as well as the 90%-quantile for high intakes. The bodyweight of the individual respondents was used in those cases where the result of the intake calculation is stated as intake per kg bodyweight.

Assessment of daily intakes

For a large number of food items calculation of the contaminant content is difficult because the majority of measurements is below the limit of detection. The number of samples above limit of detection is displayed for selected food items in Table 1.

Table 1. Number of samples and samples above LOD for selected food items

Foodstuff	Number of samples	Samples above LOD
Chicken fat	197	5%
Turkey fat	85	8%
Beef fat	385	14%
Pork fat	884	7%
Milk, Danish	248	1%
Milk, foreign	41	0%
Cheese, Danish	40	13%
Cheese, foreign	166	39%
Butter, Danish	126	2%
Butter, foreign	22	9%
Eggs	280	1%
Eel, raw	130	100%
Herring, raw	26	96%
Mackerel, raw	20	70%
Rainbow trout, raw	273	87%
Salmon, raw	20	80%
Trout, raw	77	100%

It appears from Table 1 that contents of PCB153 are found predominantly in fish and only a limited number of samples of animal fat, milk and eggs have content above the limit of detection. The largest contributions of organochlorine environmental contaminants are assumed to derive from fish, meat, dairy products, and eggs. As the intake contribution from fruits and vegetables are smaller and have relatively large limits of detection it is not included in the intake calculations. For environmental contaminants such as PCB, it may be assumed that they occur everywhere in the environment and therefore in all fatty food of animal origin. When calculating the average contents of the various substances, values below limit of detection e.g. the content

may be zero or it may be just below the limit of detection. To compensate for this fact in calculations of average contents, values below the limit of detection are set to one-third of the limit of detection. This approach will probably lead to an overestimation of the contents in those cases where no contents were found in any samples and an underestimation in those cases where the contents were found in almost all the samples.

The calculated average daily intakes of organochlorine compounds are presented in Table 2. Furthermore, the 0.90 quantile for the daily intake are given. The intake of indicator ΣPCB was calculated on the basis of the sum of average contents of the 10 indicator PCB congeners monitored.

Table2. Calculated intakes as µg per day

Substance	**Average (µg/day)**	**0.90 quantile (µg/day)**
PCB153	0.10	0.17
Indicator PCB-sum	0.90	1.41

A histogram for the intake distribution for adults of PCB153, which is often used as an indicator for PCB, is shown in Figure 1[3]. The distribution for the intake of milk and cheese is more evenly distributed than for e.g. fish, of which many eat next to nothing and a few eat a lot. For PCB the contribution from fish is greater, which causes the histogram to appear lopsided.

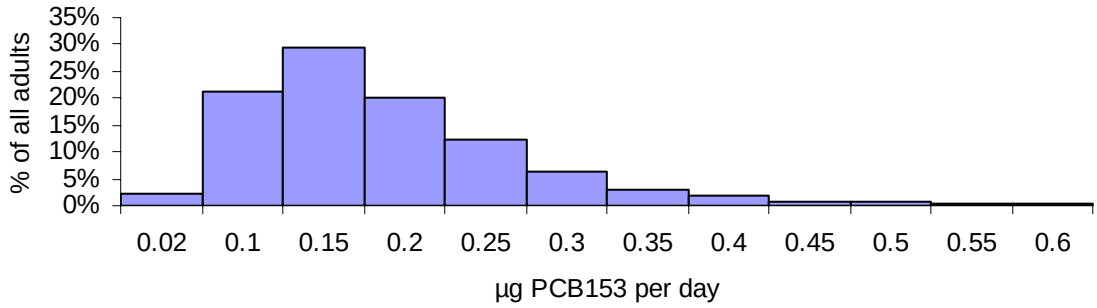

Figure 1. Daily intake of PCB153 (µg per day), distribution for adults

Contributions of individual foods groups to the daily intake

Figure 2 shows the estimated contributions of individual food groups to the average daily intake of PCB153. The group of fats includes the contributions from composite products, butter, vegetable oil and cod liver oil. Especially fish contributes to the average daily intake of PCB153, but also meat and fats are important contributors. Foods where many samples have contents below the limit of detection may nonetheless be important contributors to the calculated average intake, if the limit of detection is relatively high and the consumption is of a certain size. For example the contribution from eggs, fats, meat and milk products originates from only a few samples with content above the limit of detection.

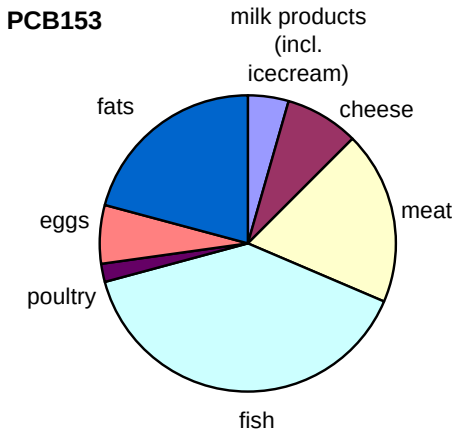

Figure 2. Adults, estimated contributions of various food groups to intakes of PCB153.

Conclusions

The Danish population's average daily intake has been estimated to 0.10 µg/day for PCB153 and 0.90 µg/day for the sum of ten indicator PCB. Persons having a relatively high intake of the substances (the 0.90 quantile) are estimated to consume approximately twice as much, whereas persons with special intake patterns, e.g. a substantial consumption of cod liver or cod liver oil, may have even higher intakes. The highest contributions to the intake of the organochlorine environmental contaminants are from fish and meat.

Acknowledgments

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